Using the VRAE Personal Multigas Monitor

Firmware v 2.00D

RAE SYSTEMS

Training Agenda:

- VRAE features
- Turning on the VRAE
- Recommended Daily Start-up Procedure
- User displays
- Alarm modes
- Programming displays
- Calibration

VRAE Features: Sensors

- Oxygen: 0-30%
- Combustibles (Dual Range):
  - ✓ 0-100% by Volume
  - ✓ 0-100% of LEL
- Toxic gas sensors: Select up to four from CO, H_2S, SO_2, NO, NO_2, Cl_2, ClO_2, HCN, NH_3, PH_3
- LEL/O_2 + 3 Toxics or LEL + 4 Toxics
- ClO_2 requires retrofit Teflon tubing inside

RAE SYSTEMS

VRAE Features: Reliability

- Extremely rugged for extensive field use
- Weather-proof case
- Temperature range of -4ºF to 113ºF (-20ºC to 45ºC)
- 4-Way power: NiMH, Alkaline or run continuously on 110 VAC and 12 VDC
- Runs 10 hours continuously
- RFI protection against radio interference
- Intrinsically safe: Class I, Division I, Groups A, B, C, D
- LEL Over-Range Protection

RAE SYSTEMS

VRAE Features: Rugged Boot

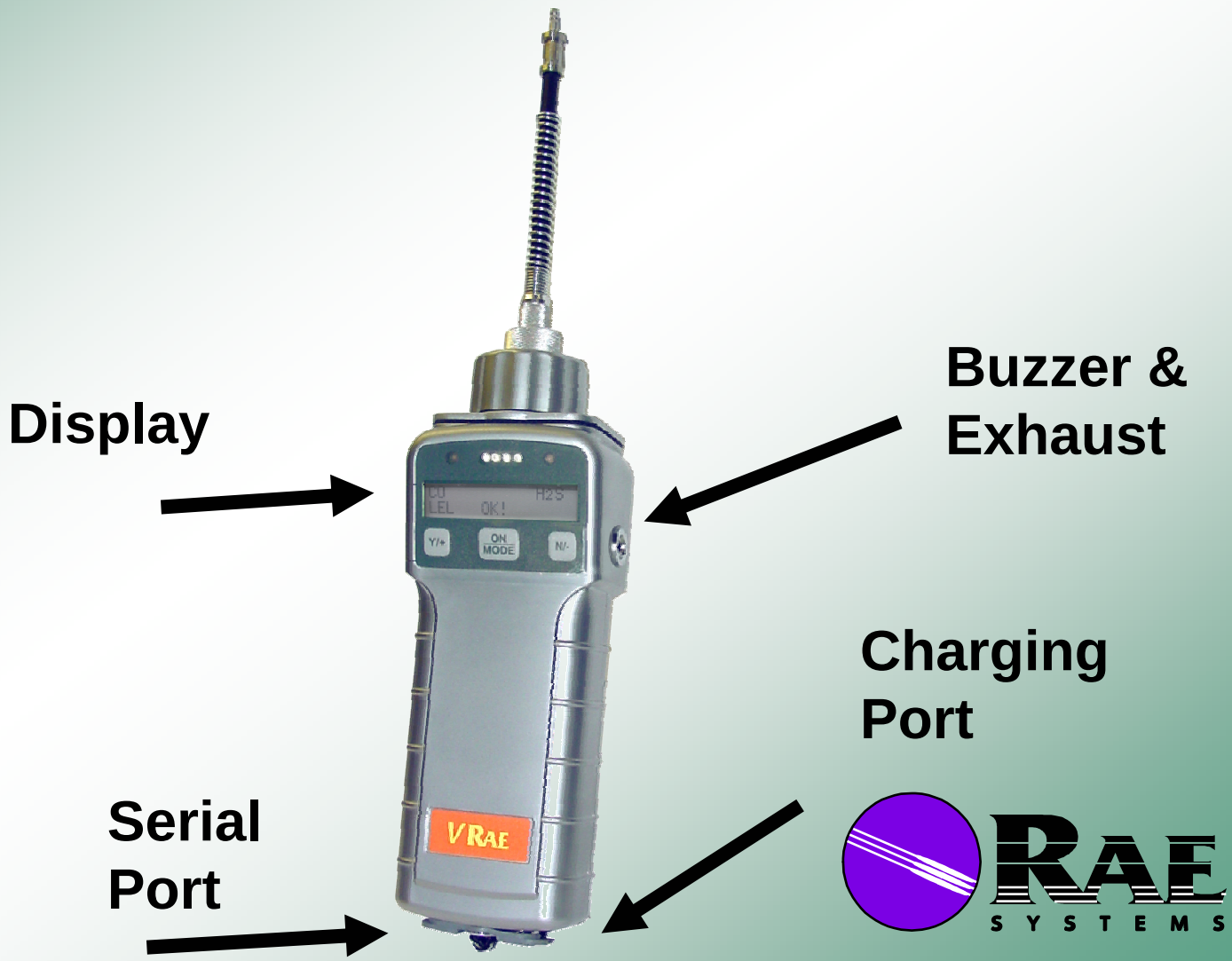
Teflon Probe

Rugged Rubber Boot

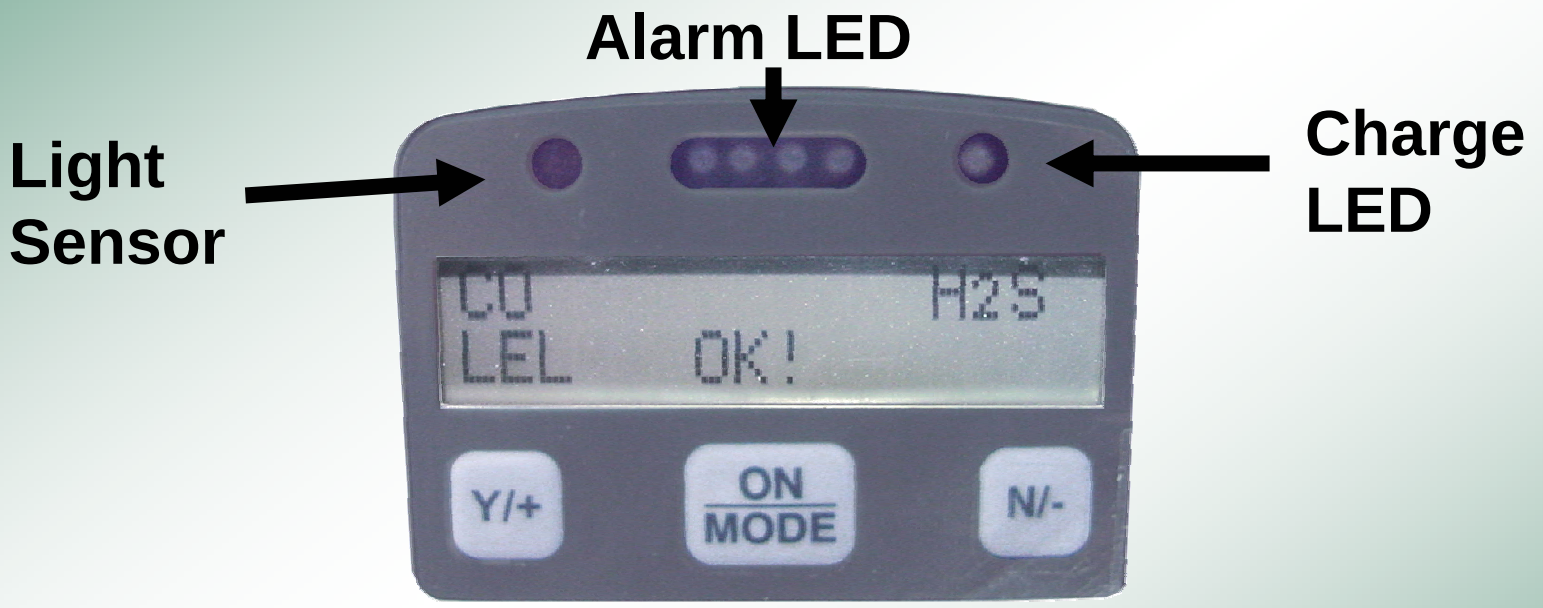
Belt Clip

RAE SYSTEMS

VRAE Features: Rugged Case



VRAE Features: Simple Faceplate



- Three buttons on a sealed membrane faceplate:
  - ✓ Y/+ : clears & tests alarms
  - ✓ N/- : turns on manual backlight for 90 seconds
  - ✓ ON/MODE

RAE SYSTEMS

VRAE Features: Internal Pump

- Makes remote sampling easy
- Sample draw over 200 feet horizontally and 90 feet vertically!
- Moisture and dust trap for added protection
- Pump stall feature: when moisture is detected or when pump is blocked the pump will shut off, protecting the VRAE from potential damage
- ~500 cc/min at High flow, ~ 25% less at Low flow. Default is high

RAE SYSTEMS

VRAE vs QRAE Plus

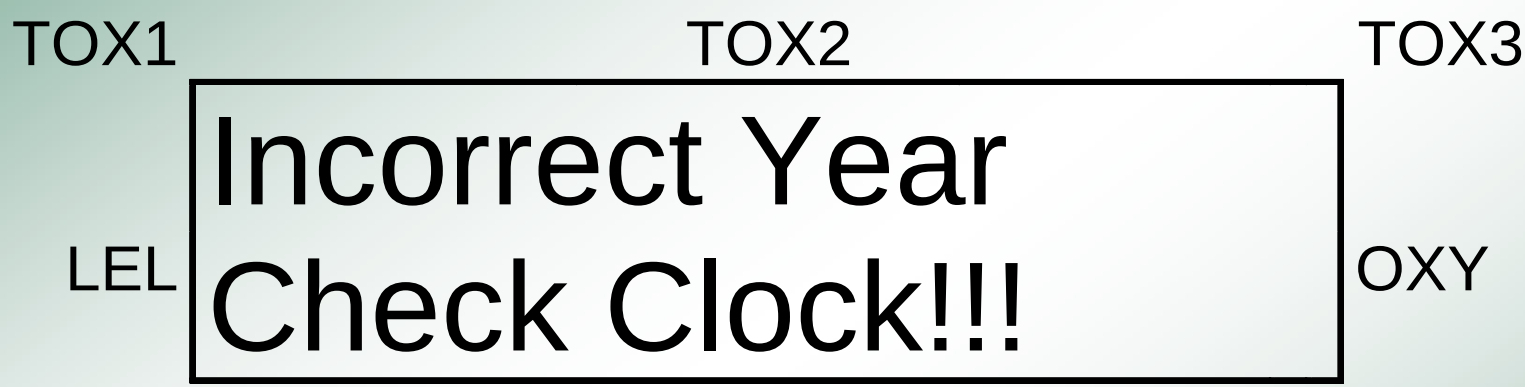
- Stronger Pump (500 vs. 350 cc/min)
- Firmware & tubing for ClO_2 Sensor
- Better firmware for VOL Sensor
- Up to 4 Toxic Gas Sensors vs. 3
- Different form factor
- Higher price

VRAE Start-up: Turning On

- Unplug VRAE from charger
- Hold “MODE” Key to turn on
- Alarm will beep once
- Watch display screen for messages such as:
  - ✓ Sensors installed & their warranty expiration
  - ✓ Alarm limits
  - ✓ Last calibration date
  - ✓ User/Alarm/Datalog modes
- Warm-up will take approximately 90 seconds

RAE SYSTEMS

VRAE Start-up: Warnings



- If this screen appears during the start-up just acknowledge it with the “Y” key and follow the procedure for setting the clock.
- The battery has gone dead and the VRAE has detected a mismatch between the date code on the sensors and its internal clock.

VRAE Start-up: Warnings

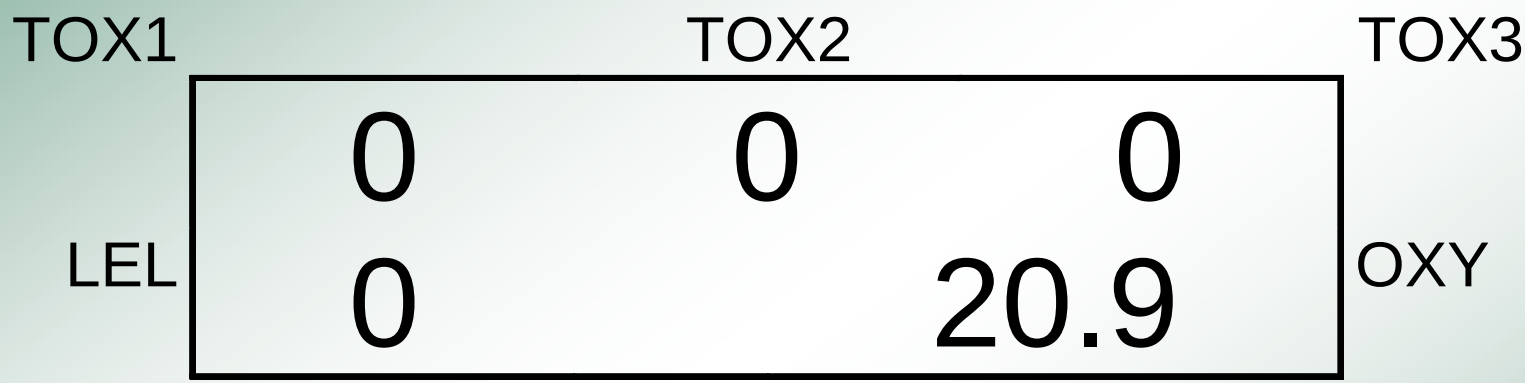
TOX1 TOX2 TOX3

LEL O_2 Installed OXY
Warranty Expired

- This is a warning screen. As long as the sensor calibrates properly it is valid to continue using it. Acknowledge by pressing the “Y” key to continue warm-up.
- To ensure proper operation, RAE Systems recommends replacing sensors at the end of their warranty period.

RAE SYSTEMS

VRAE Start-up: Check Sensor Zero



- After 90 sec. warm-up, the VRAE should display readings for all of the installed sensors
- If there is no alarm, and the sensor readings are within limits, then the VRAE is ready for use.

RAE SYSTEMS

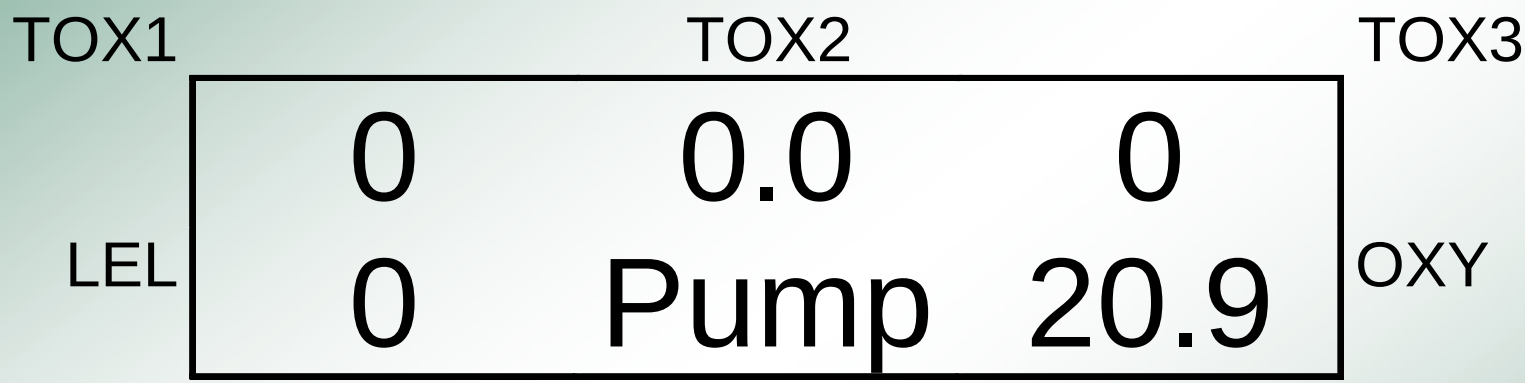
VRAE Start-up: Check Sensor Zero

TOX1	TOX2	TOX3
0	0	0
LEL 0-3		20.6-21.2 OXY

- If any reading is outside these limits, wait a few minutes then check again.
  - ✓ If readings are in limits use the unit
  - ✓ If readings are still outside these limits perform "Fresh air calibration"

RAE SYSTEMS

VRAE Start-up: Pump Alarm



- Every time the VRAE is used it is important to check pump flow
- Block the filter on the pump inlet
- Reset pump alarm by pressing the “Y” key
- If pump does not go into alarm, check for loose/cracked filter or service pump

3 Display Modes

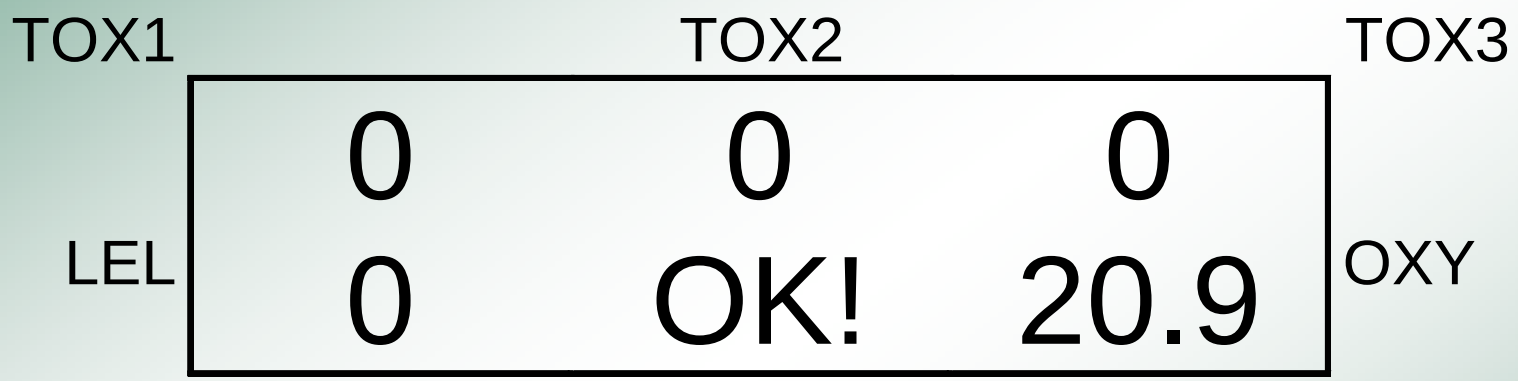
- **Program Mode:** 12 screens and programmability for most advanced users
- **Display Mode:** 12 screens, no programmability
- **Text Mode:** 3 screens and has password to get into programming (default)

Comparison of Display Modes

Program (12)	Display (12)	Text (3)
Sensor ID	Sensor ID	Battery
PEAK	PEAK	PC Comm
MIN	MIN	Sensor ID w/OK
STEL	STEL	
TWA	TWA	
Battery	Battery	
Time/Date/Temp	Time/Date/Temp	
Start Datalog*	Start Datalog*	* Will not show if no datalogging option or auto datalogging
LEL Gas	LEL Gas	
Pump Speed	Pump Speed	
LEL/VOL	LEL/VOL	
PC Comm	PC Comm	

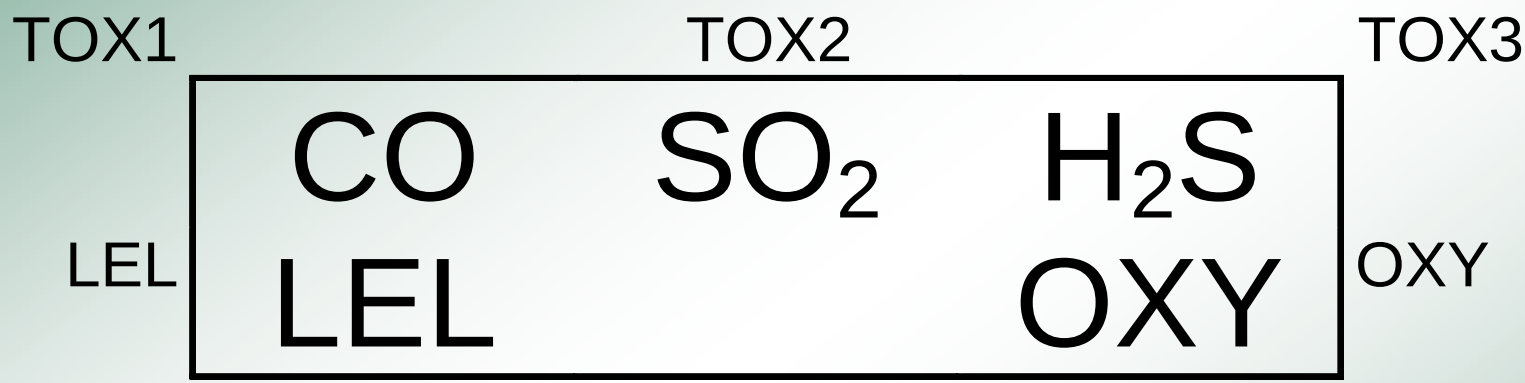
RAE SYSTEMS

Instantaneous Reading (Main Display)



- In text mode, “OK!” is displayed if there is no alarm

Instantaneous Reading (Main Display)

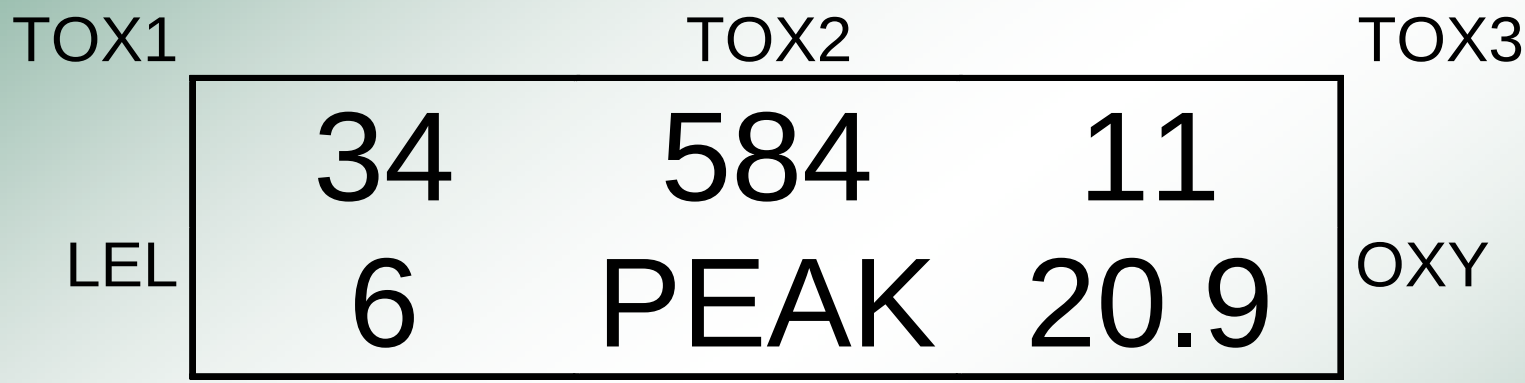


- CO: Carbon Monoxide sensor
- SO_2: Sulfur Dioxide sensor
- H_2S: Hydrogen Sulfide sensor
- LEL: Combustible gas sensor
- OXY: Oxygen sensor
- Tap “MODE” key to proceed

RAE SYSTEMS

This screen is deleted in Text Mode

Peak Reading Display

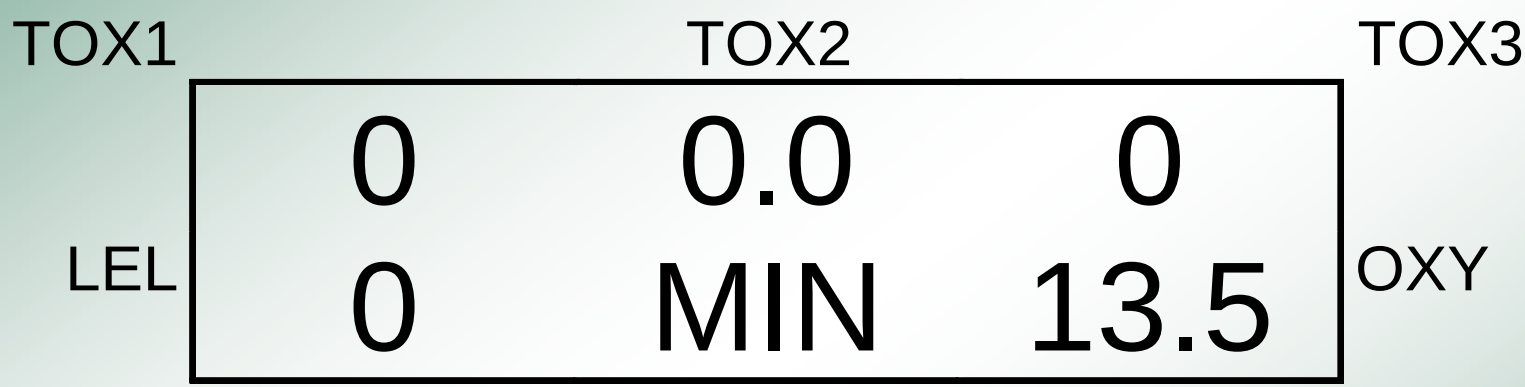


- Holds Highest reading since VRAE was turned on or Peak cleared
- Tap “MODE” key to proceed to next screen

RAE SYSTEMS

This screen is deleted in Text Mode

Minimum Reading Display



- Holds Lowest reading since VRAE was turned on or Min cleared
- Tap “MODE” key to proceed to next screen

This screen is deleted in Text Mode

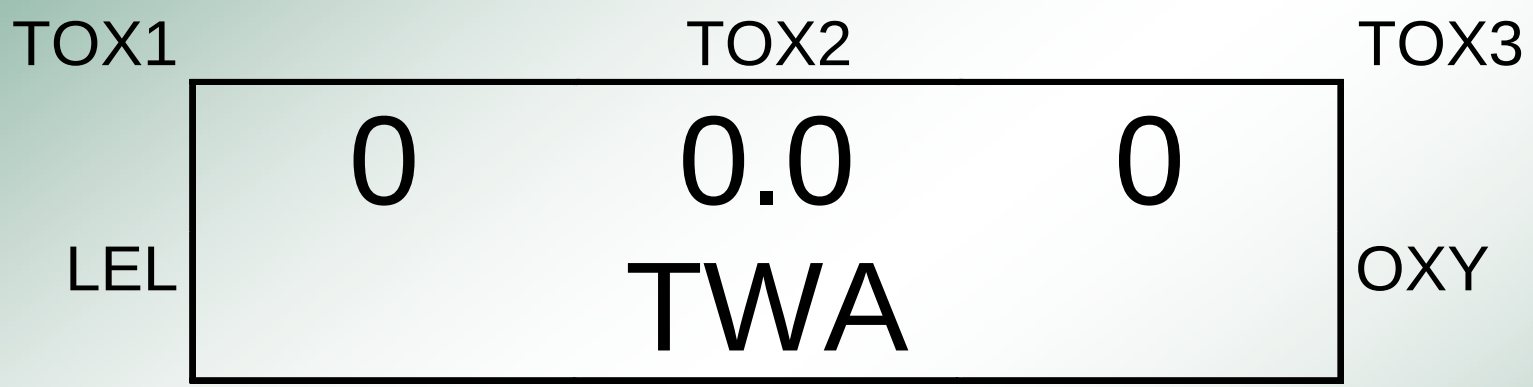
STEL Display

- Short Term Exposure Limit (average for the past 15 minutes)
- Displays “****” until VRAE has been on for 15 minutes
- STEL only is calculated for toxics
- STEL alarm beeps once a second
- Tap “MODE” key to proceed

RAE SYSTEMS

This screen is deleted in Text Mode

TWA Display

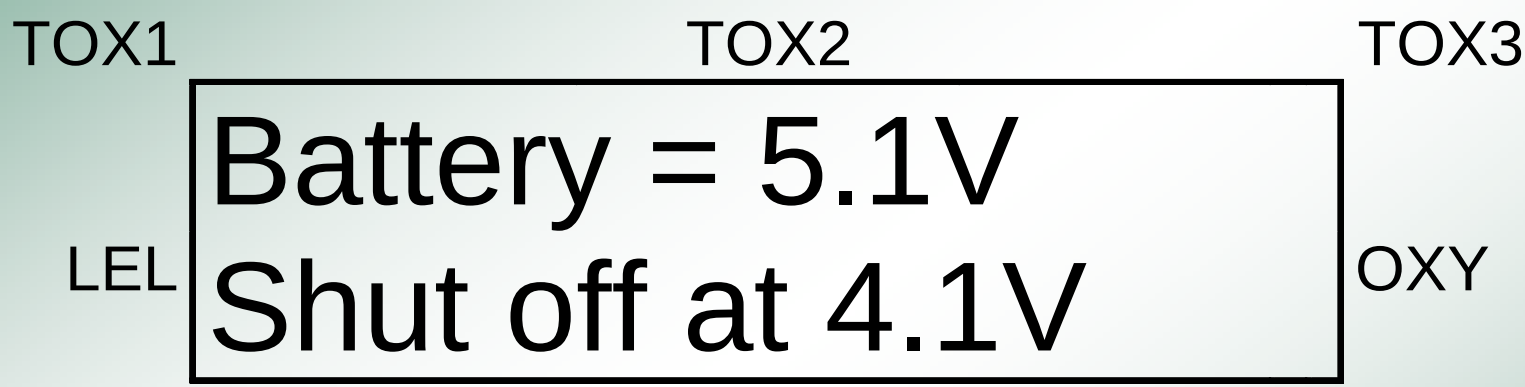


- Time Weighted Average is the accumulated dose in ppm-hours since the VRAE was turned on, divided by 8 hours
- TWA only is calculated for toxics
- TWA alarm beeps once per second
- Tap “MODE” key to proceed to next screen

RAE SYSTEMS

This screen is deleted in Text Mode

Battery Voltage Display

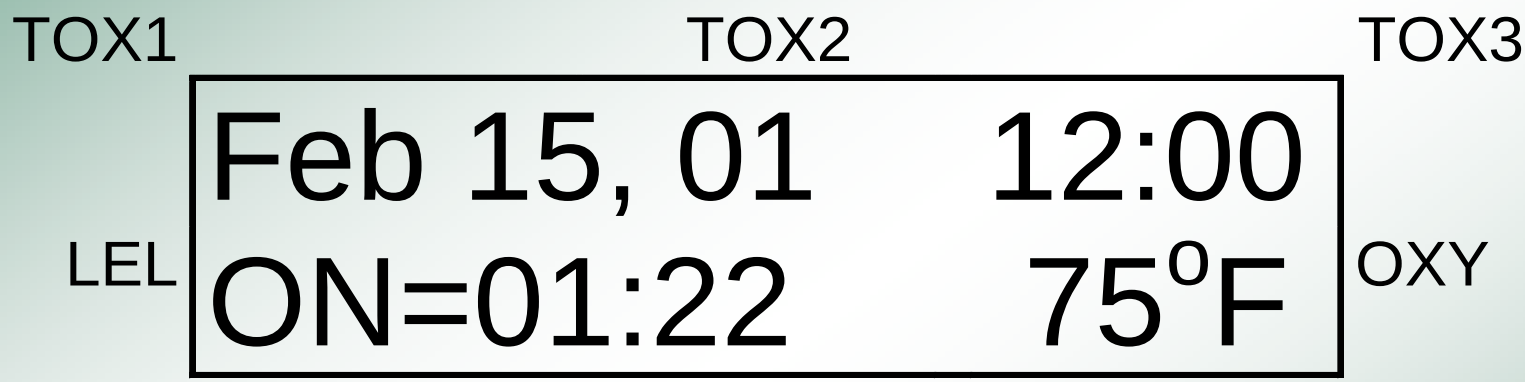


- VRAE shuts down when battery voltage drops below 4.2 volts
- Normal full charge is over 4.8 volts
- Tap “MODE” key to proceed to next screen

RAE SYSTEMS

This screen is deleted in Text Mode

Date/Time/Run Time/Temp. Display

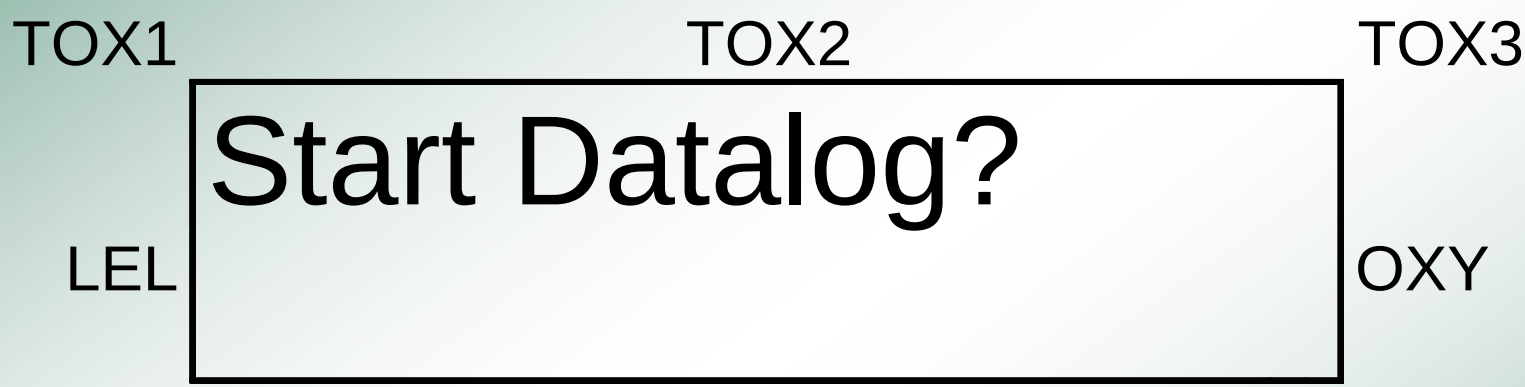


- Date, Time of day
- Accumulated time in hours and minutes since the VRAE was turned on
- Temperature in Centigrade or Fahrenheit (operating range -20 to +45ºC, -4 to +113ºF)
- Tap “MODE” key to proceed

RAE SYSTEMS

This screen is deleted in Text Mode

Datalog Mode Display



- Manual: logs if “Y/+” key is pushed now
- Automatic: this screen is deleted and it logs data when as soon as the VRAE turns on
- Scheduled: logs data at a preset date & time
- Periodic**:** start and stop datalogging daily based on preset time

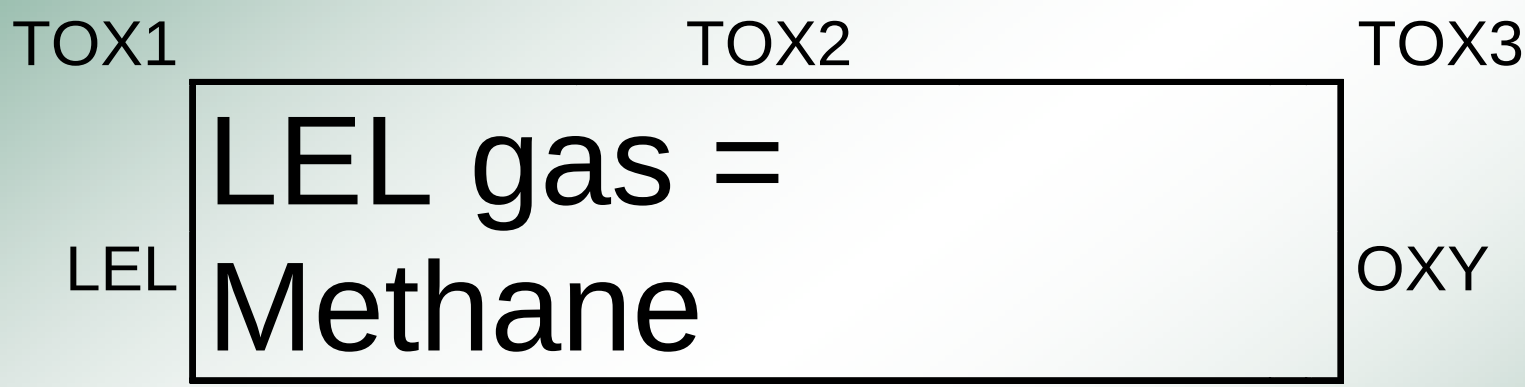
This screen is deleted in Text Mode

Datalog Mode Display

- A small “L” displayed in the left center of the screen indicates datalogging is active
- Will datalog 16,000 points (53 hrs of data)
- Tmax = (#Points/#Sensors)*Sample Period = (16,000/5)*60 = 192k secs = 53 hours
- Entering programming pauses datalogging

This screen is deleted in Text Mode

LEL Units Display

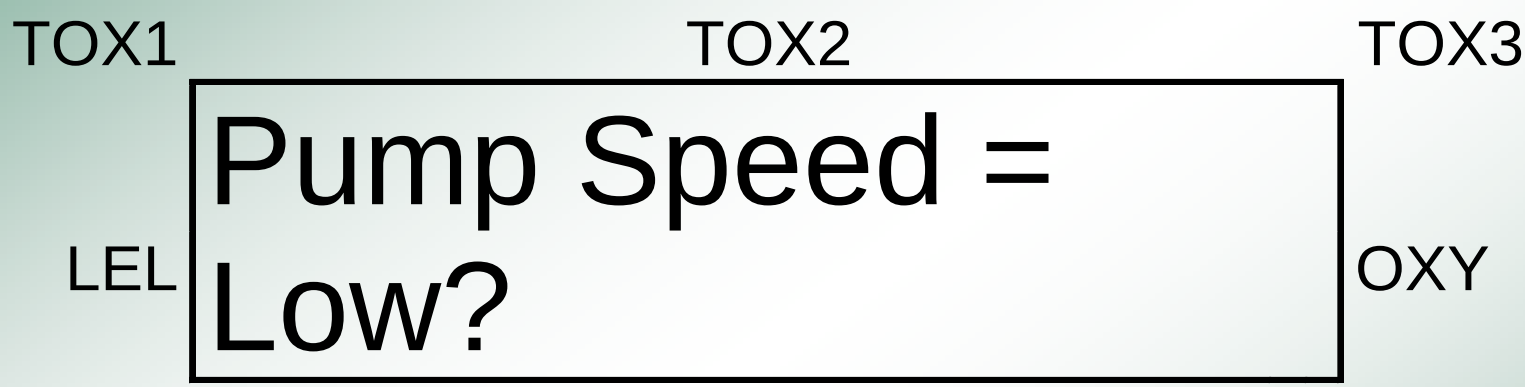


- Target Gas for LEL displayed here (VRAE is currently measuring LEL in units of methane)
- Correction Factor can only be changed in programming mode
- Tap “MODE” key to proceed to next screen

RAE SYSTEMS

This screen is deleted in Text Mode

Pump Speed Display

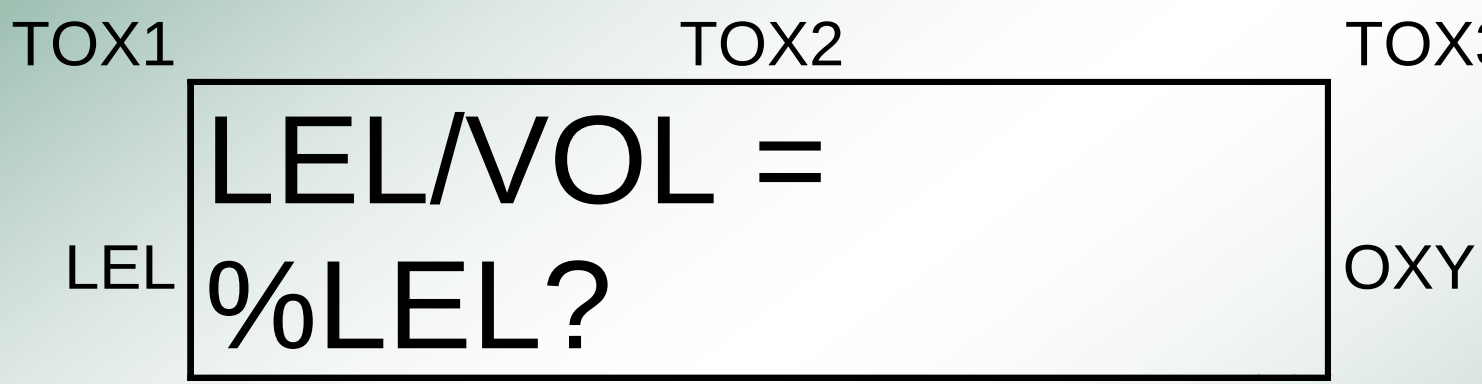


- Low speed flow rate: 300-400 cc/min
- High speed flow rate: 400-500 cc/min
- Tap “MODE” key to proceed to next screen

RAE SYSTEMS

This screen is deleted in Text Mode

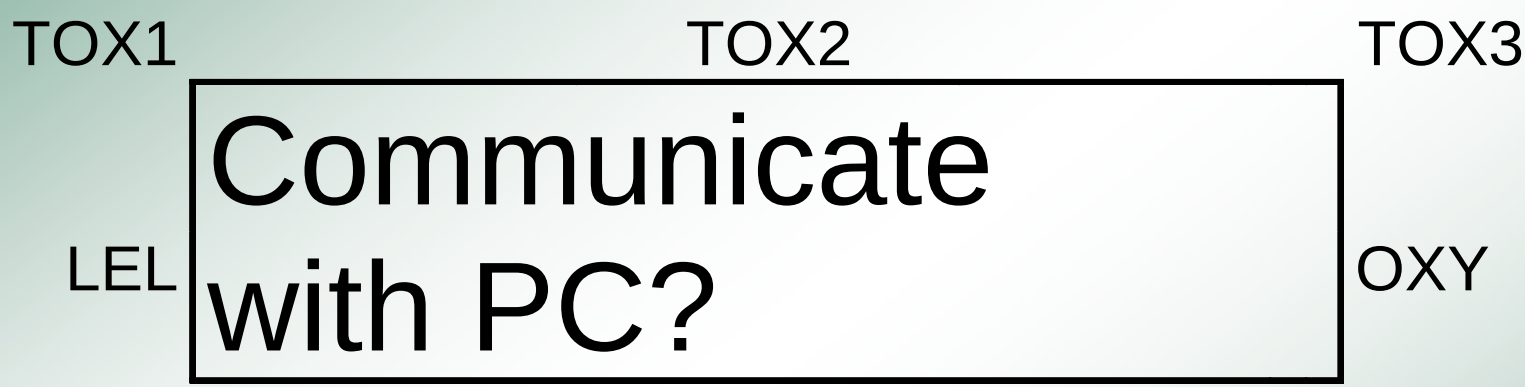
LEL/VOL Display



- % LEL Display – “%LEL?”
- %VOL Display – “%VOL?”
- Auto Ranging Display – “Auto?”
- In Auto Mode, after reaching 100% LEL reading switches to %VOL; then must turn off to re-enter LEL readings
- Tap “MODE” key to proceed

RAE SYSTEMS

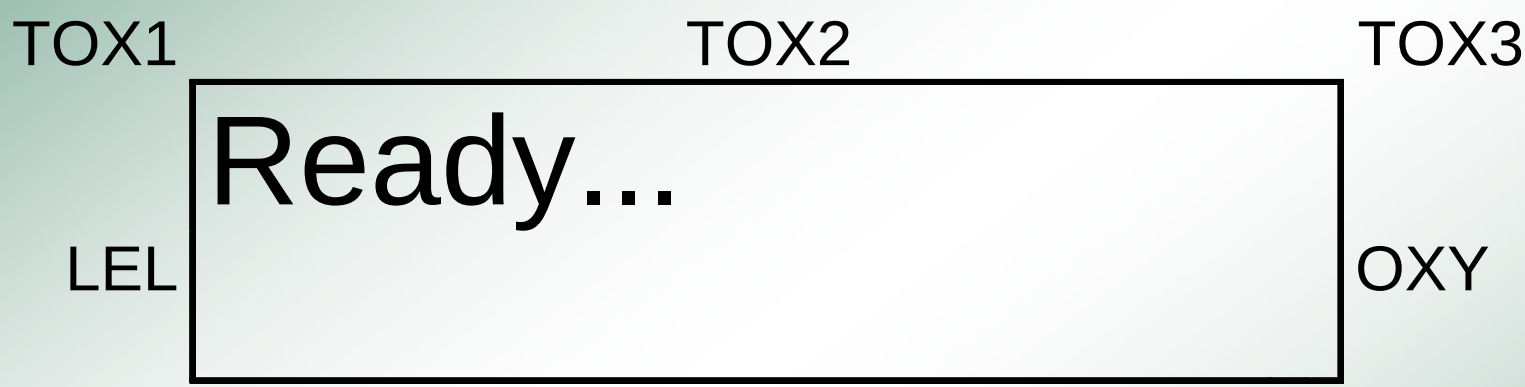
Communicate with PC Display



- If “Y/+” key is pushed then VRAE will display “Monitor will Pause. OK?”
- If “Y/+” key is pushed again the VRAE will display “Ready...” until it receives a signal from the computer or the “MODE” key is pressed.
- Tap “MODE” key to proceed

RAE SYSTEMS

Communicate with PC Display



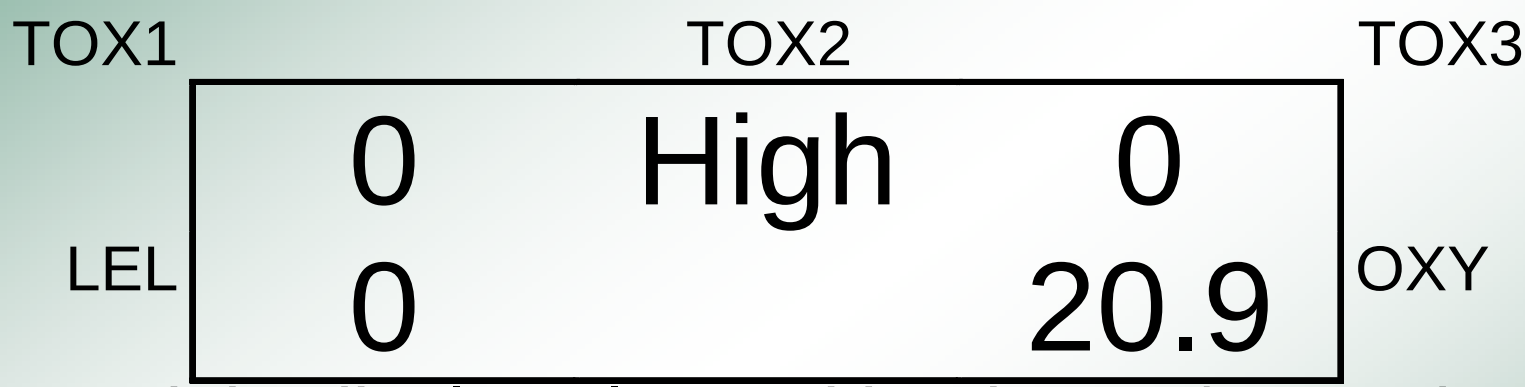
- ***When the VRAE is in this communication standby mode it stops monitoring gas concentrations and stops datalogging.***
- Datalogging must be manually restarted when exiting unless automatic datalogging is in use.

VRAE Alarm Signals

- The VRAE will provide audible and visual alarms to alert users to unsafe states
- It is extremely important to note that during the following conditions the alarm signals are disabled:
  - ✓ *When entering the "Communicate with PC?" standby mode.*
  - ✓ *When entering the "Calibrate Monitor" menu*
  - ✓ *When viewing data in the "View or Change Datalog?" menu*

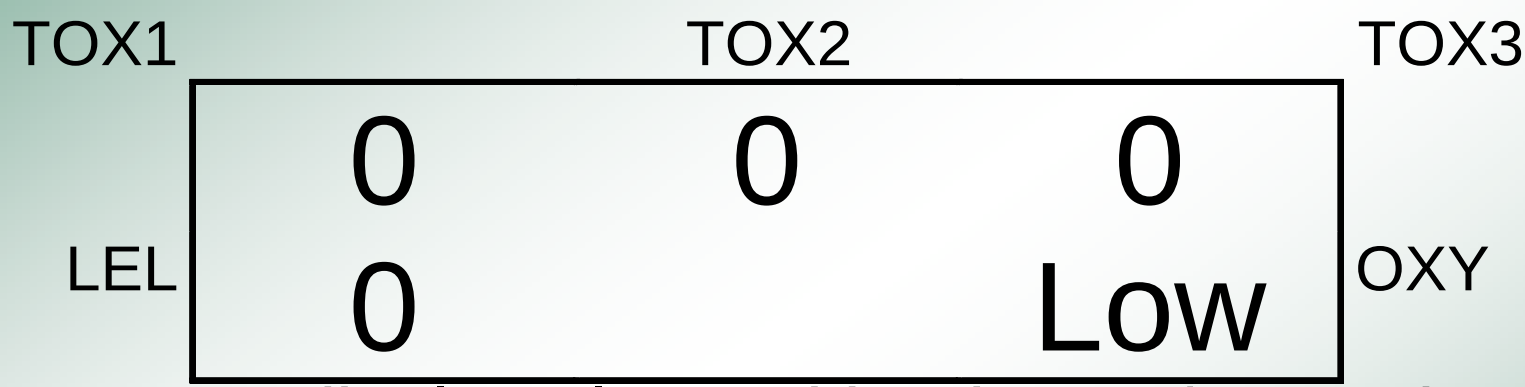
RAE SYSTEMS

VRAE Alarms: High



- "High" display along with 3 beeps/second audible/visible alarm and flashing display backlight indicates that TOX2 sensor (SO_2) has exceeded high alarm setpoint (10 ppm default set point for SO_2).
- Press "Y/+" key to clear if latching alarm

VRAE Alarms: Low

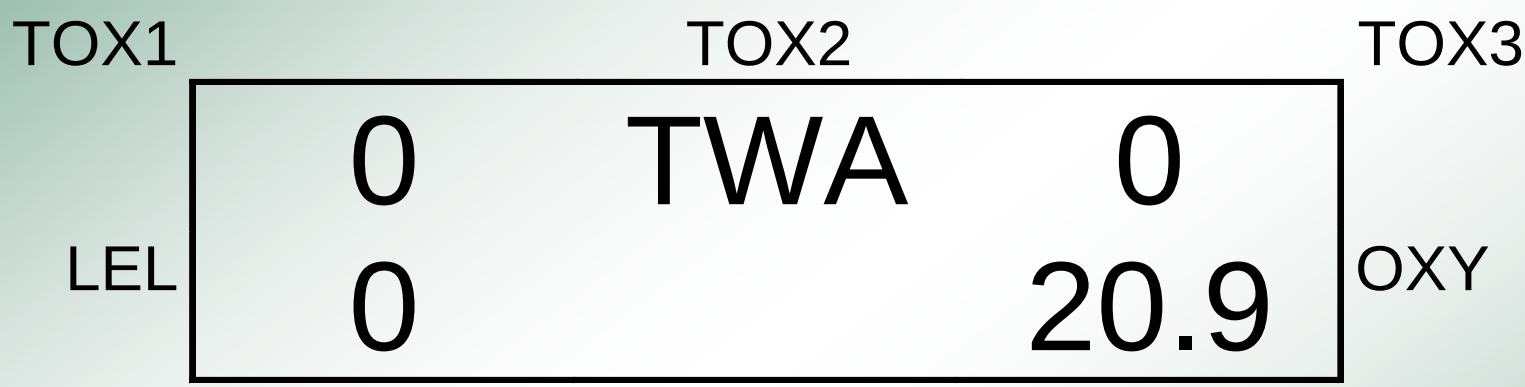


- "Low" display along with 2 beeps/second audible/visual alarm and flashing display backlight indicates that Oxygen sensor has gone into low alarm (less than 19.5% Oxygen default)
- Press "Y/+" key to clear if latching alarm

VRAE Alarms: STEL

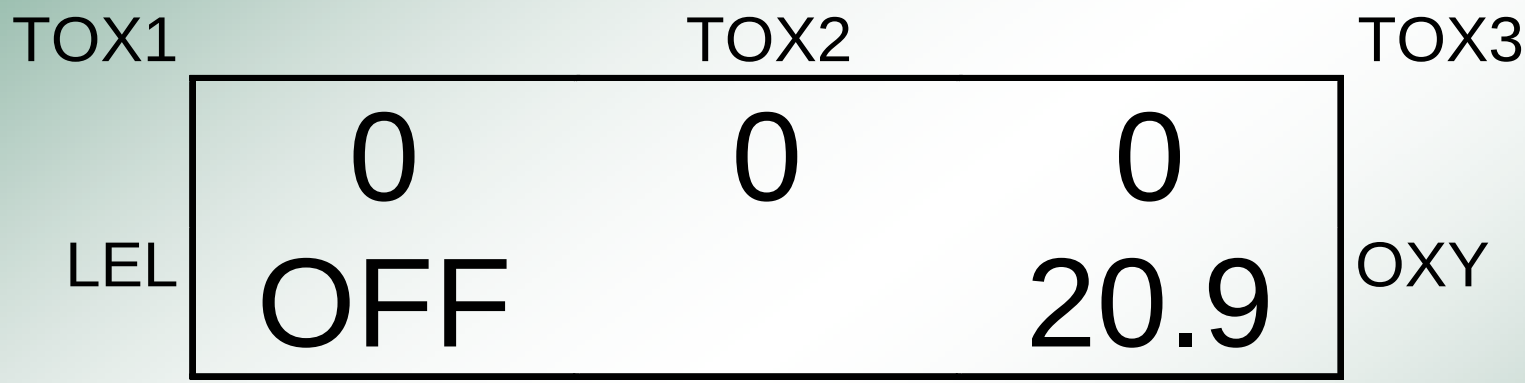
- "STEL" display along with a 1 beep/second audible/visual alarm indicates indicates that SO_2 sensor has exceeded STEL alarm setpoint (5 ppm default)
- ***This alarm will only clear after 15 minutes in clean air or if the VRAE is turned off!***

VRAE Alarms: TWA



- "TWA" display along with a 1 beep/second audible/visual alarm indicates indicates that SO_2 sensor has exceeded the TWA alarm setpoint (2 ppm default)
- ***This alarm will only clear after moving to clean air and then turning off the VRAE***

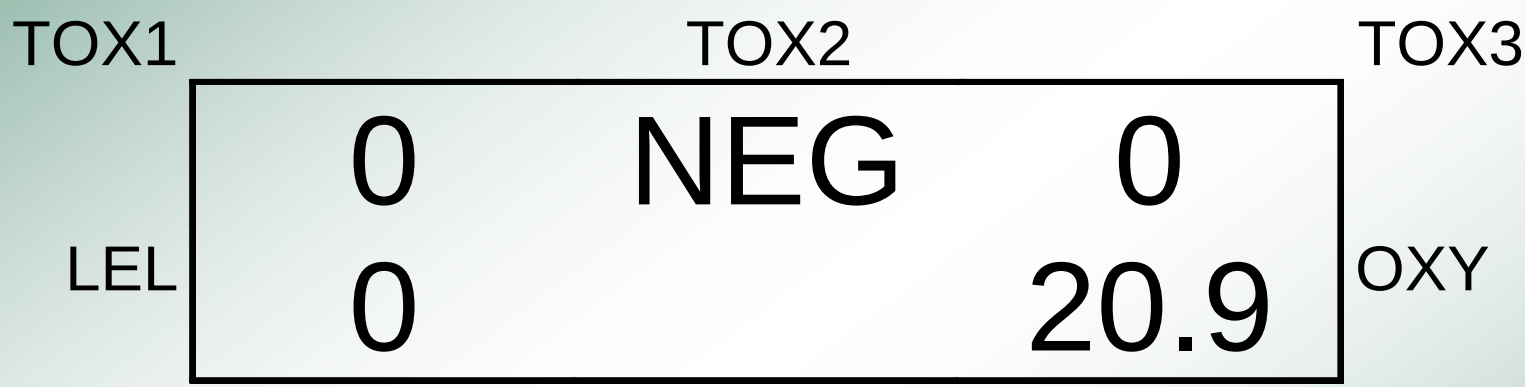
Alarms: LEL OFF



- “OFF” display along with a 3 beeps/second audible/visual alarm indicates that LEL sensor has been exposed to too much gas and has shut off to protect the sensor.
- Move the meter to clean air and press the “Y” key to reset.

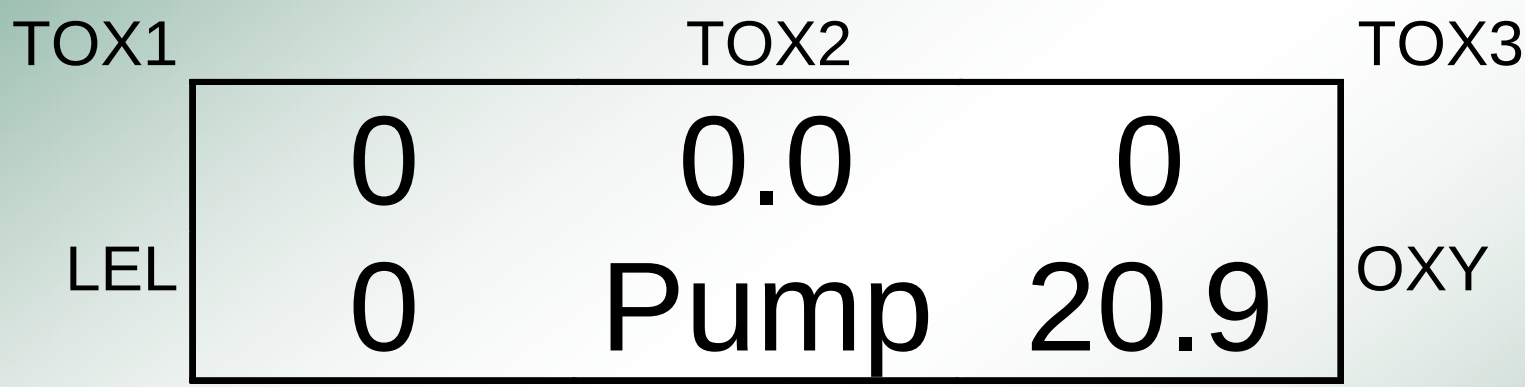
RAE SYSTEMS

Alarms: NEG



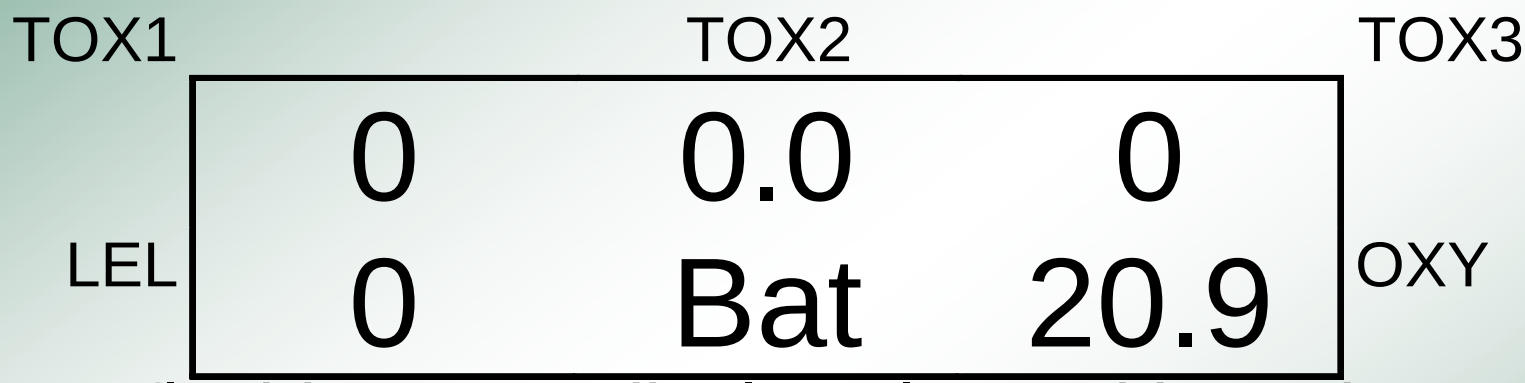
- "NEG" display along with a 1 beep/second audible/visual alarm indicates indicates that SO_2 sensor has drifted negative (below zero) because the sensor was zeroed in an area containing SO_2.
- ***Perform "Fresh Air Calibration" in an area clear of all toxics.***

VRAE Alarms: Pump



- “Pump” display along with 3 beep audible alarm indicates that pump has stopped due to line clog
- Pump alarm is a latching alarm
- Clear line/filter and press “Y/+” key to clear alarm and restart pump

VRAE Alarms: Low Battery



- A flashing “Bat” display along with a 1 beep alarm every 10 seconds indicates that the battery voltage has dropped below 4.35 V and it will shut down in 20-30 minutes
- Quickly complete confined space entry and charge VRAE or install alkaline battery

RAE SYSTEMS

VRAE Alarms: Memory Full

- A flashing “MEM” display along with a 1 beep/second audible/tactile/visual alarm indicates that the datalog memory is full.
- Clear datalog in “View or Change Datalog?”

Getting Into Programming

- *Hold “MODE” and “N/-” keys for 5 sec. to get in Programming Mode*
- If VRAE asks a question “?”
  - ✓ Answer “Y” or “N”
- To Accept or Escape
  - ✓ Use “MODE” Key
  - ✓ repeatedly pushing the “MODE” key will always eventually return user to main display

RAE SYSTEMS

Programming Menus

- Calibrate Monitor?
- Change Alarm Limits?
- View or Change Datalog?
- Change Monitor Setup?
- Change Sensor Configuration?
- *Choose (Y) to accept or (N) to move on*

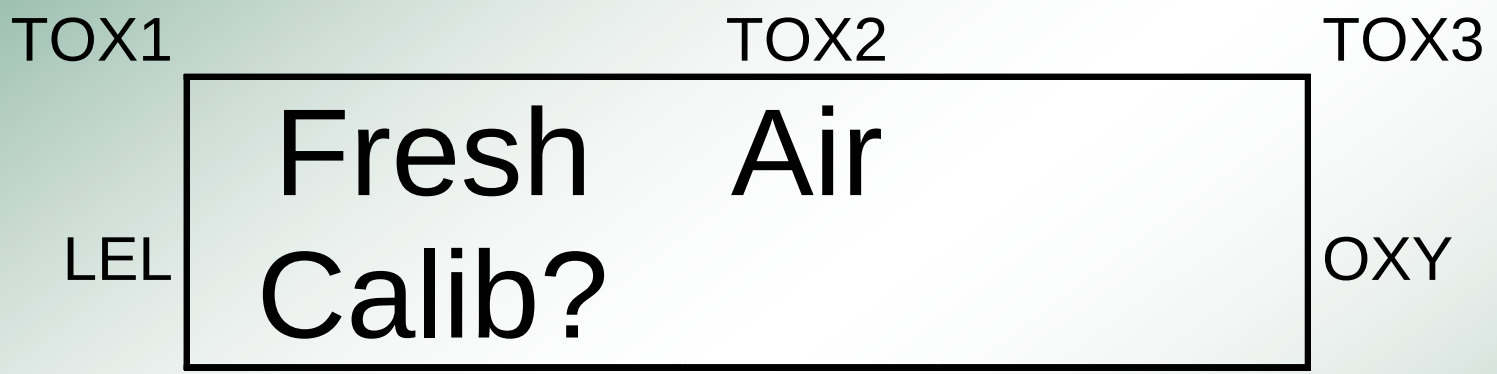
RAE SYSTEMS

Calibrate Monitor?

- Fresh Air Calibration?
  - ✓ *Make sure air is clean!*
- VOL% Zero Calibration?
- Multiple Sensor Calibration?
- Single Sensor Calibration?
- Modify Span Gas Value?
- Change LEL/VOL Span Gas?
  - ✓ *Choose (Y) to accept or (N) to move on, MODE to escape*

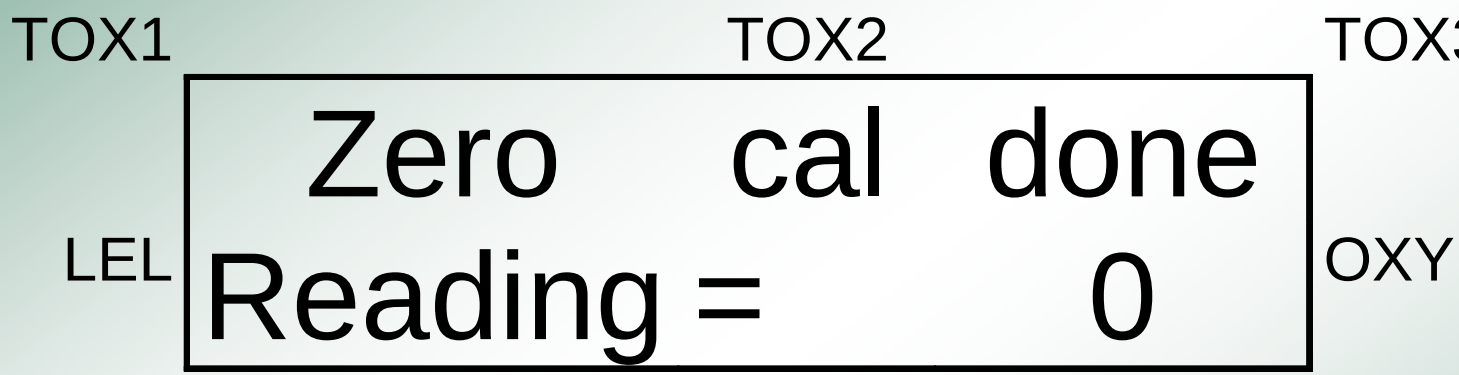
RAE SYSTEMS

Fresh Air Calibration



- At “Fresh Air Calibration” press “Y/+” key
- Zero’s all sensors including LEL but not VOL and sets O_2 to 20.9%.
- Press “Y/+” key to continue

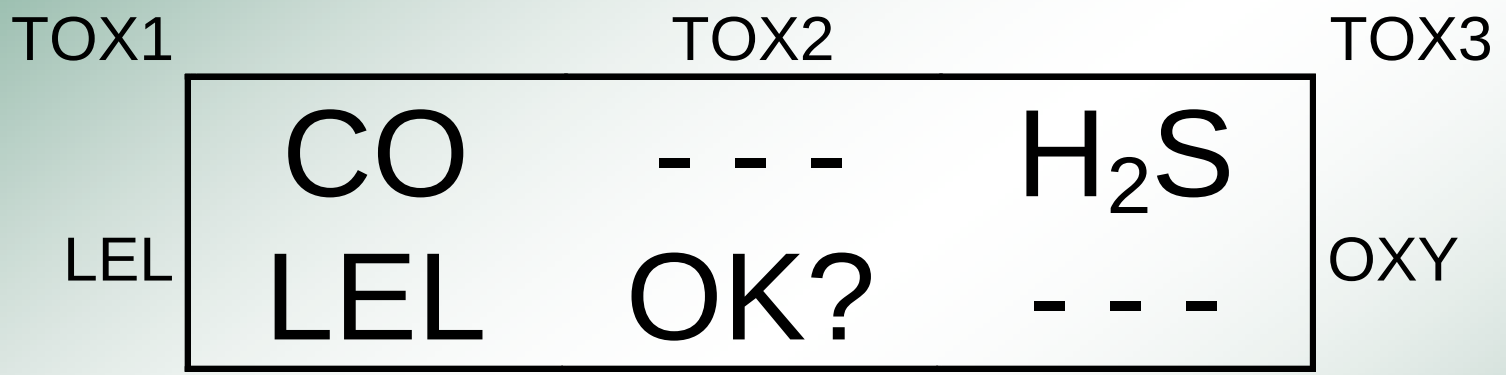
VOL% Zero Calibration



- At “VOL% Zero Calibration” press “Y/+” key (Only shown in VOL or Auto LEL/VOL Mode)
- Apply VOL zero gas (often pure N_2)
- Zero’s only VOL sensor, does not affect O_2
- Successful zero cal appears as screen above
- Press “Y/+” key to continue

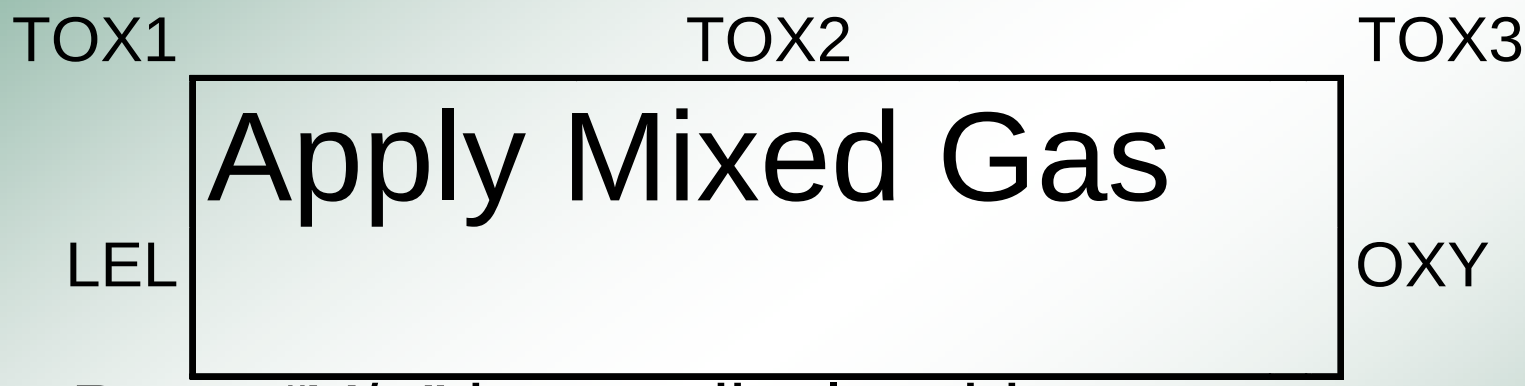
RAE SYSTEMS

Multiple Sensor Calibration



- At “Multiple Sensor Calibration” press “Y/+” key
- For CO/H_2S/LEL mixed gas calibration the next screen should appear as above

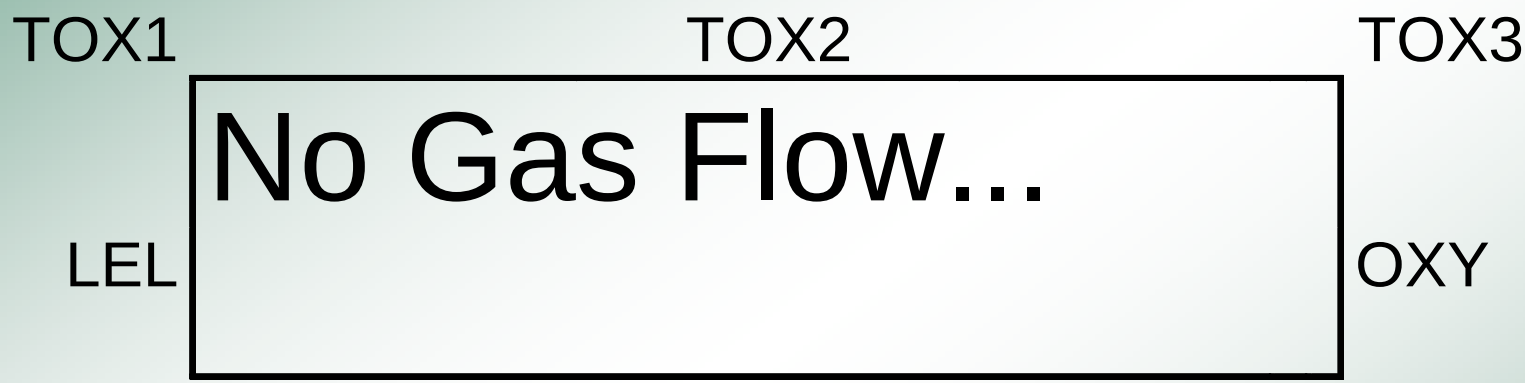
Multiple Sensor Calibration



- Press “Y/+” key to display this screen
- Attach calibration gas regulator to mixed gas cylinder and attach calibration hose to VRAE
- Turn on calibration gas
- Follow instructions on screen

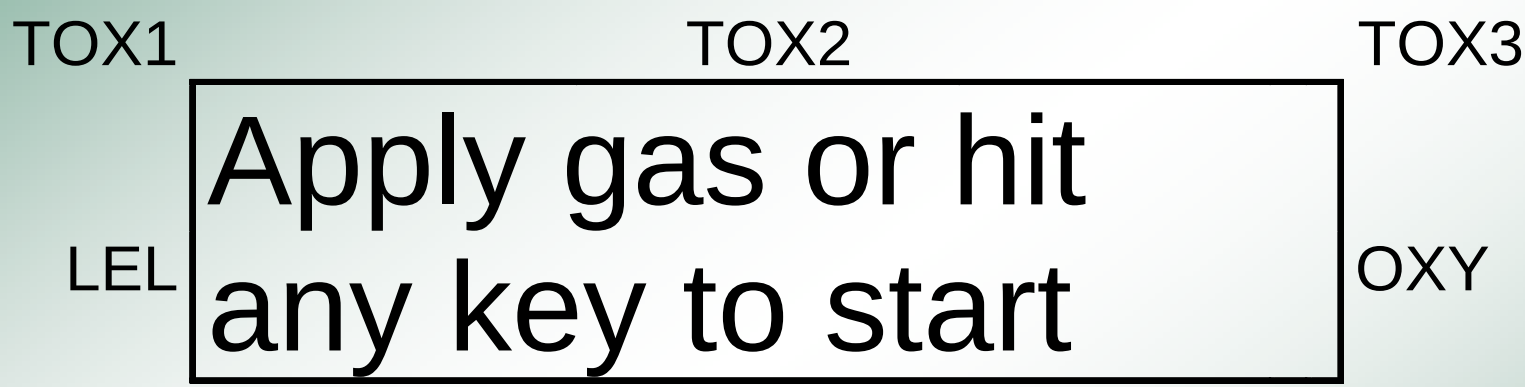
RAE SYSTEMS

Multiple Sensor Calibration



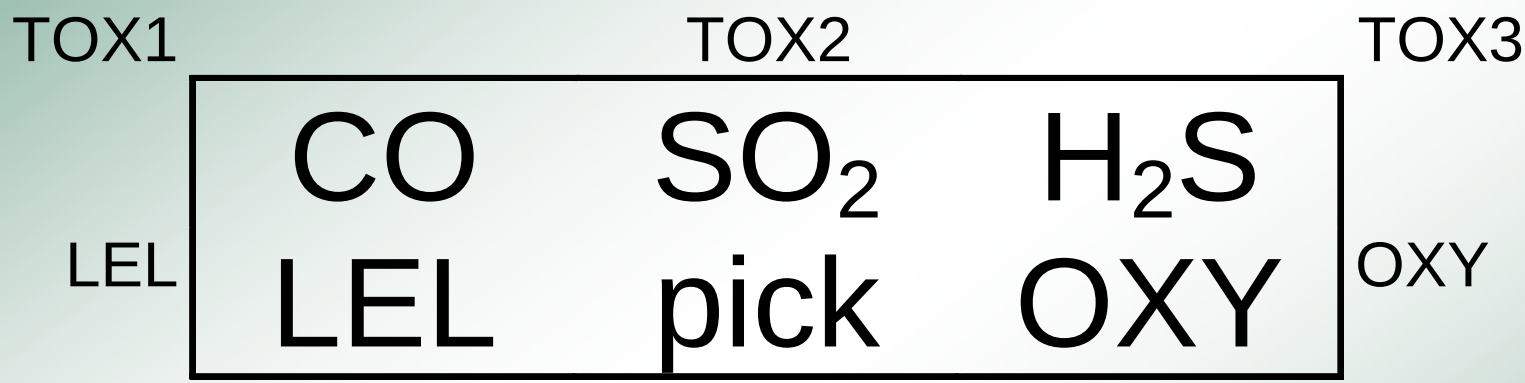
- If you get this screen check for gas flow, the VRAE will not perform span calibrations unless it senses calibration gas

Multiple Sensor Calibration



- Try again after you have verified that the gas is correct and it is flowing properly
- Follow instructions on screen
- Disconnect regulator from gas cylinder when complete calibration

Single Sensor Calibration



- Toxic sensors can be calibrated individually if necessary
- At “Single Sensor Calibration” press “Y/+” key
- Use “MODE” to select sensor

RAE SYSTEMS

Single Sensor Calibration

- Attach calibration gas regulator to calibration gas cylinder
- Attach calibration hose to VRAE and make sure it is tight
- Turn on cal gas (Pre-soak slow sensors)
- With cursor on the appropriate sensor press “Y/+” key
- Follow instructions on screen
- Repeat if necessary for other gases
- Disconnect regulator

RAE SYSTEMS

Single Sensor Pre-Soak

- Standard Cal time is 60 sec except for ClO2, which is 150 sec
- Some slow sensors require pre-equilibration

Sensor	Response Time t_{90} (seconds)	Total Cal Time (seconds)	Pre-exposure Time for 1-min Cal Time
HCN	200	230	170
ClO_2, NH_3	150	150	90
Cl_2, PH_3	60	120	60
CO, H_2S, SO_2, NO, NO_2, O_2, LEL, VOL	≤40	60	0

RAE SYSTEMS

Calibration

- Modify Span Value
  - ✓ Allows you to change the calibration gas values to use other cal gases
  - ✓ Do not change if you are using the RAE Systems cal gas supplied with your meter
- Change LEL/VOL Span Gas?
  - ✓ Allows you to change the calibration gas, which by default is methane
  - ✓ Do not change if you are using the RAE Systems cal gas supplied

Change Alarm Limits?

- Change High alarm limit?
  - ✓ 3 Beeps per second (“High”)
- Change Low alarm limit?
  - ✓ 2 Beeps per second (“Low”)
- Change STEL alarm limit?
  - ✓ 1 Beep per second (“STEL”)
- Change TWA alarm limit?
  - ✓ 1 Beep per second (“TWA”)

Choose (Y) to accept or (N) to move on, MODE to escape

RAE SYSTEMS

View or Change Datalog?

- Reset Peak and Minimum?
- Clear All Data?
- Change Datalog Period?
- Select Data Type?
- View Datalog?
- Enable/Disable Datalog?

Choose (Y) to accept or (N) to move on, MODE to escape

Change Monitor Setup?

- Change Site ID?
- Change User ID?
- Change Alarm Mode?
- Change User Mode?
  - ✓ “Program”
  - ✓ “Display”
  - ✓ “Text”

Change Monitor Setup?

- Change Real Time Clock?
- Change Backlight Mode?
- Change Password?
- Change Pump Speed?
- Change Averaging Method?
- Set Temperature Unit? (ºC or ºF)

Choose (Y) to accept or (N) to move on
MODE to escape

Change Sensor Configuration?

- Change LEL/VOL Sensor Type?
- Enable/Disable Sensor?
- Change Dilution Ratio?
- Change LEL/VOL Gas Selection

Choose (Y) to accept or (N) to move on, MODE to escape

VRAE: Power Off

- Hold Mode Key for full 5 seconds
- Audible alarm will beep and display will read “Power-down in ...5 seconds”
- Plug 12 VDC charger into VRAE charge port when not in use

VRAE: Smart Charging

TOX1 TOX2 TOX3

LEL

Start Battery
Deep discharge?

OXY

- NiMH does not need deep discharge
- Full charge can take up to 10 hours
- With the smart charging circuitry, removing the charger is not necessary.

RAE SYSTEMS

VRAE: Trickle Charging

TOX1 TOX2 TOX3

Charging…..
Battery=5.9V

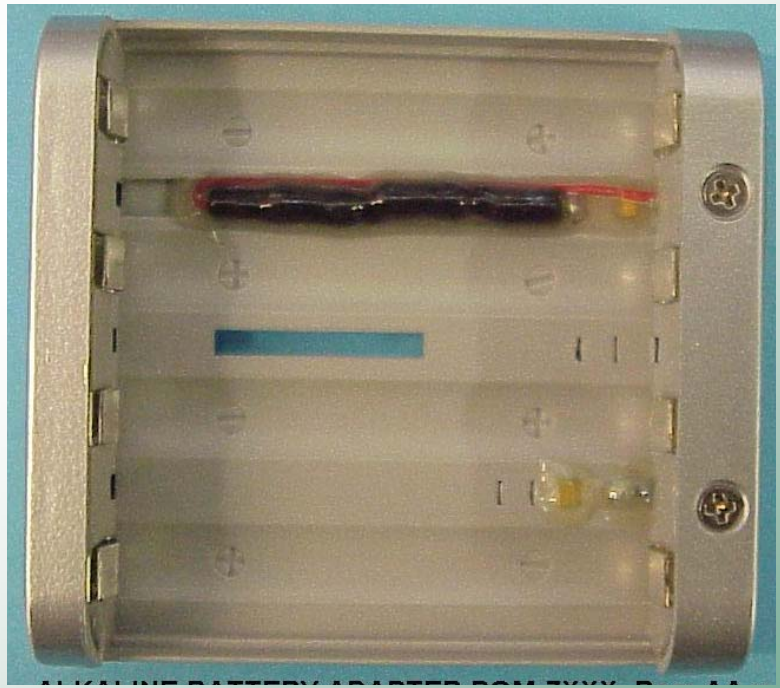
LEL OXY

- Turning off and on power to charger will reset charge to high and may burn-out battery if done repeatedly

RAE SYSTEMS

VRAE: Alkaline Adapter

- Accepts 4 AA alkaline batteries
- Provides 10 hours of operation
- Make sure that cable runs in groove between batteries or it won't fit
- When reattaching VRAE lid, seat it first at back by batteries then push the front down



Questions?

RAE SYSTEMS